Title (Hydrographic Research for Marine Vertical Positioning and Seabed Classification)

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LONG-TERM GOALS

Our top-level goal is to improve the length of baselines that RTK-GPS 3-D positioning at the several-centimeter level can be done in the marine environment. Our other top goal is to improve the science of sediment classification through backscattered acoustic data, and provide methods that can be taken operational.

OBJECTIVES

Our objectives for the RTK-GPS efforts are as follows.

1) Evaluate different methods to estimate the tropospheric delay to sufficient accuracy to resolve carrier-phase integer ambiguities when base-station receiver and mobile receivers are beyond the correlation length-scales of the wet troposphere. A prime concern is that best method will get the job done in the most passive manner possible.

2) Create a database of RTK-GPS data, in both temperate and subtropical climates, with static baselines and continuously varying baselines that can be used to evaluate the methods

Our objectives for the sediment classification efforts are as follows:

1. Procure a custom dual-frequency side-scan sonar towfish that is optimized for sediment classification work and properly calibrate the instrument.

2. Develop a technical base and establish procedures and technical instrument descriptions for sediment classification using multibeam and side-scan sonar equipment to enhance the utility if seafloor data collected in hydrographic surveys.

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14. ABSTRACT
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APPROACH

The RTK-GPS approach is along several fronts. The RTK-GPS data are going to be collected in two sustained field projects. The first is an onshore base-station receiver paired with a rover receiver on a 3-m discus buoy that will be moored in the Gulf of Mexico. The buoy will remain at a fixed location and the base-station will be fixed at a distance over 20 nm away. The buoy will be instrumented with a standard meteorological package to characterize the local surface atmosphere, an ADCP, current meter, conductivity gauge, temperature gauge, pressure gauge, and motion sensors to characterize the local sea conditions, and a bottom package with conductivity, temperature and a digiquartz pressure gauge to get an independent measure of sea level changes. Iridium modems and VHF radio communication to nearby oil platforms will provide the real-time data and RTK link. Stephan Howden and Denis Wiesenburg are working with Norman Guinasso and John Walpert of the Geophysical Environmental Research Group at Texas A&M to instrument the buoy and set up both the real-time data telemetry system and the data serving via the web.

Figure 1. Stephan Howden inspects Axys 3-m discus buoy at the Texas A&M GERG facility.

The second field project utilizes a ferry (the Princess of Acadia) and two GPS reference stations in the Bay of Fundy to provide variable baselines for RTK positioning. The two stations each have a base-station receiver, a meteorological station, and are collocated with tide gauges, one of which is on loan to the project from Dalhousie University. The ferry has a rover receiver and a meteorological station. Marcelo Santos of the University of New Bruswick (UNB) is leading this effort.

Sunil Bisnath and David Wells of USM, along with Ben Remondi of the XYZ's of GPS Inc., and Dong Hyun Kim of UNB are leading the wet tropospheric delay model efforts and evaluating how to integrate various methods into the RTK positioning algorithms.

WORK COMPLETED

At this stage in the project many of the completed tasks have to do with the ordering and calibrating of equipment for the buoy and ferry systems.

RTK-GPS Buoy:

Much of the equipment has been received, including the 3-m discus buoy that was delivered to GERG. In March, Stephan Howden visited GERG to examine an Axys 3-m buoy bought and being outfitted for the TABS program. Many of the meteorological and oceanographic sensors have arrived and a server for the data telemetry and web serving has been acquired. Plans have been made to test the data telemetry and web serving with a tide gauge while the buoy is being assembled.

Princess of Acadia:

HydroMetrica LTD has imported into Canada all of the equipment that will be used for the ferry project A data management strategy for the ferry project has been designed and an ftp website has been established at USM to receive raw and processed data, and to provide access to data and results to all program participants. Data from the Digby GPS and weather stations will be collected by science teachers at the local high school, and a weekly CD burned and sent by courier to UNB. Arrangements are in place to access the Canadian Meteorological Service numerical weather database and download models for precipitable water vapour and other parameters at sub-daily intervals. Work has been accomplished in creating a UNB website for the project that will go online when the data stream begins. A full systems test of the three GPS / meteorological stations has been completed, and the sensors are presently being deployed in the field.

Figure 2. Testing of Campbell Scientific weather stations and Novatel GPS receivers on the roof of the UNB Engineering building.

Wet-Troposphere Delay/RTK Positioning Algorithm Studies:

Ben Remondi began the evaluation of the sensitivity of the tropospheric path delay to small errors in surface meteorological parameters. He applied his covariance study to determine the future impact

proposed GPS constellation changes and used the results to advise DoD in their current Block III effort.

Dong Hyun Kim of UNB, has made further improvements to the UNB baseline RTK software in his effort to make it more automatic and operational for medium and long baselines. The upgraded software has been delivered to USM. Research is ongoing into algorithm improvements for GPS-based residual tropospheric delay estimation, and means to ingest numerical weather forecast information into GPS data processing.

Sediment Classification:

A customized towfish from Marine Sonics has been purchased and it is presently being built.

RTK Workshop:

Planning has begun for the RTK workshop. The tentative dates are 16-18 March, at the USM Gulf Park Campus.

RESULTS

The 7 months in FY03 that were funded on the project have been mainly used for building the infrastructure of the project. As such, meaningful technical results will follow in FY04.

IMPACT/APPLICATIONS

Acheiving sucess in the goals of this research program will have tremendous broad impact for ocean science and commerce and for national security. The ability to position vessels within several cm over a broad region will allow ships to safely navigate safely with smaller under-keel clearances, allow more precise bathymetric charting, and allow more precise bathymetric-topographic lidar surveys, An example of a benefit to naval operations is that RTK-GPS buoys for tidal control of hydrographic surveys in hostile areas could be deployed with more flexability in the choice for base-station location.

Although all raw acoustic bathymetric survey data has the poteential for determining sediment type, presently nearly all bathymetric survey data are archived in a form that precludes retrospective analysis for sediment calssification. Improving the science of acoustic sediment classification to the level that it can be accomplished operationally will provide sediment types, in addition to soundings, from routine hydrographic surveys. This will ensure that scare resources are used to extract the maximum information possible.

RELATED PROJECTS

Testing has been completed of three new commercial, long-baseline, carrier phase differential GPS services. These positioning systems are accurate to the decimenter level under most conditions. The benefit of this evaluation is that the performance of these services can be compared against RTK GPS.

Analysis of an RTK GPS buoy for sea level monitoring (with conventional baseline lengths less than 10 km) has been done for the Naval Oceanographic Office which would like to use GPS buoys as offshore tide gauges for hydrographic surveys. The results showed that sea level could be determined to sufficient accuracy for IHO order 1 hydrographic surveys. Lessons learned from this project have been applied to the planning of the present program.

A separate, ONR-sponsored side-scan survey off the coast of Kauai, Hawaii, in support of the High-Frequency (HFX) Channel Characterization Experiment was done in August.

Another related project is our work with Optech International, the USACE, and NAVO on sensor fusion (hyperspectral and lidar) for sediment and habitat classification. We have three graduate students pursuing PhD dissertations on this subject. A natural extension of these studies is to combine the airborne data with in situ acoustic data. Funding will be pursued for such a study.